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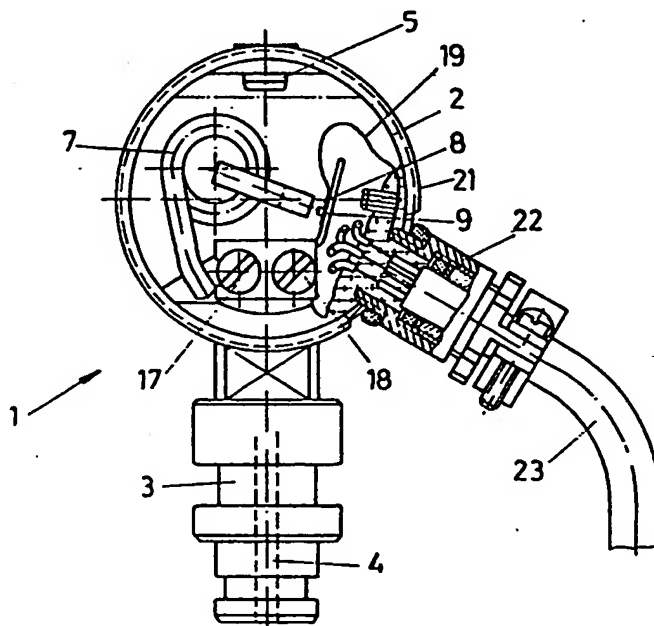
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(54) Manometer with bourdon spring and hall generator

(57) To monitor machinery and plant in mining, i.e. in particular the hydraulic support system, a manometer is used comprising a Bourdon spring 7 and a Hall generator 9 via which the movement of the Bourdon spring is converted to electrical signals and then converted for remote display and by suitable accessories also for direct display. The Bourdon spring is made with high strength and thus is suitable for overloads occurring under-ground. The magnet 8 is fixedly connected to the spring and the Hall generator to the housing, which consists of two parts. The Bourdon spring, the magnet and the Hall generator are associated with one part and the sealed-in electronics with the other.

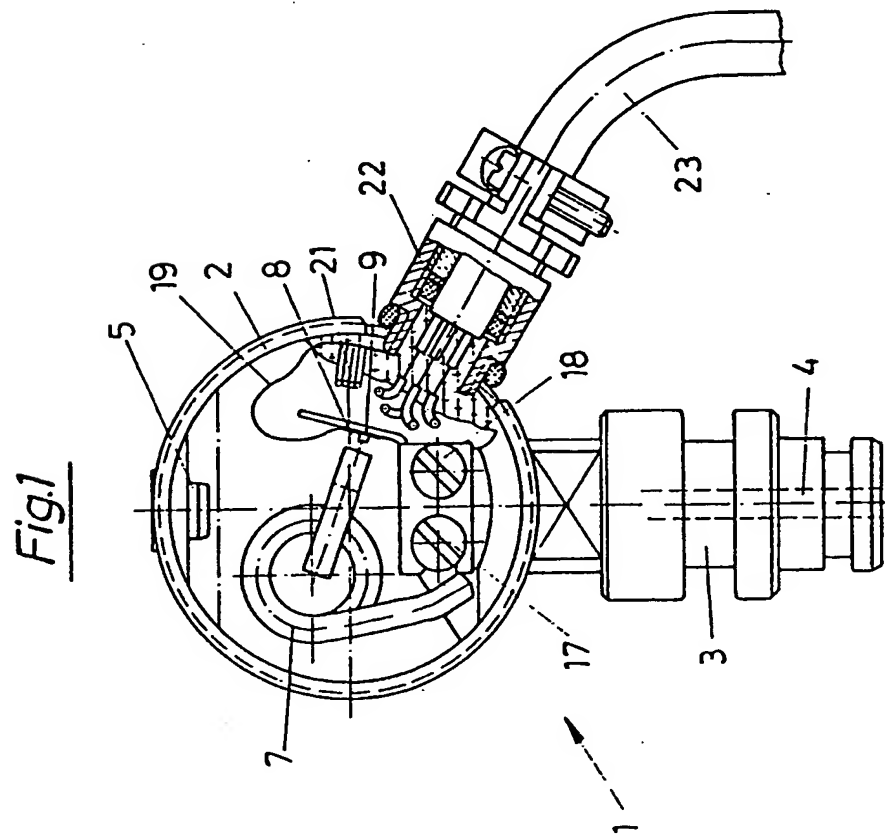
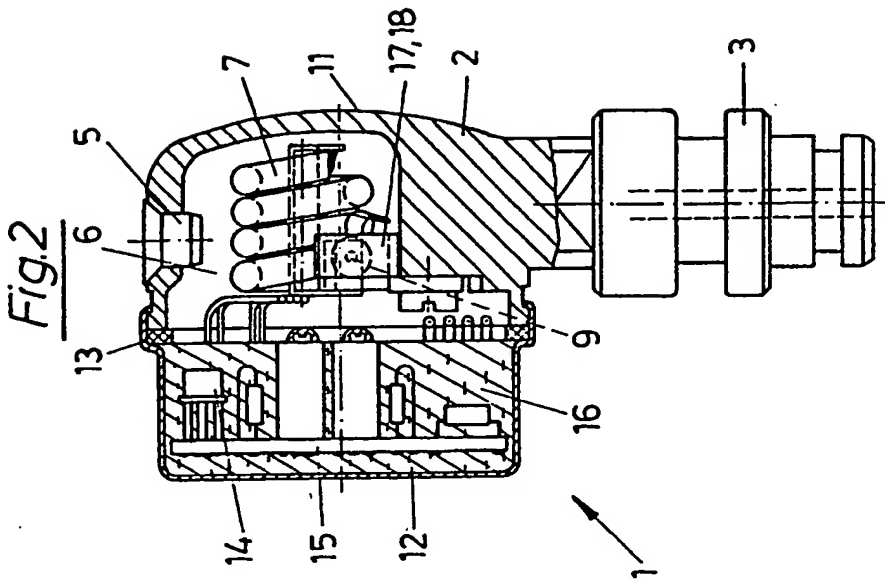
The Hall generator, secured to the housing, is aligned with the magnet and is arranged in a bridge circuit with temperature compensation, running at a constant current of about 2.5 milliamps. The housing is filled with oil for damping externally-induced vibrations in the Bourdon tube.

Fig 1



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SPECIFICATION

Manometer with bourdon spring and hall generator

5 The invention relates to a manometer with conversion of the pressure movement of the Bourdon spring accommodated in a closed housing via a Hall element serving as remote pickup and comprising a permanent magnet as exciter, which are associated with the Bourdon spring.

10 Such manometers are used in underground mining to enable continuous monitoring of the machinery and plant, in particular the hydraulic support system. The more particular purpose is to monitor the pressure in the working cylinders by simple manometers. These manometers must be compact, reliable, robust and easily replaceable. Known for this purpose are so-called spring manometers with Bourdon spring, the proportion of rotational movement of which is transmitted via a pointer mechanism over a deflection of about 270°. This monitoring is admittedly advantageously accurate but requires persons to be in the vicinity of the manometer to read the particular values. Particularly in underground mining where in the region of the face the working density is becoming increasingly smaller, such a monitoring therefore requires too much personnel, quite apart from the fact that the accuracy of the measurement results depends on the accuracy with which the reading is taken. Finally, in addition the smallest values can be detected only with very exact monitoring but these values frequently are signs of incipient damage. It would therefore be far more advantageous if the monitoring could be automated, i.e. if the values determined by the manometers could be supplied automatically to a central station, for example the face control station or the section supervising station.

15 It is known from above-ground working to use Hall generators together with manometers having Bourdon springs which together with a permanent magnet generate a magnetic field which on varying deflection of the Bourdon spring leads to mistunings which are converted into electrical signals for automatic transmission of the measured values. These known manometers cannot however readily be used for underground mining, especially since they operate with Bourdon springs with excessive deflections. Because of the necessary multiple overloadability of the nominal pressure such Bourdon springs are however not suitable for use in face supports. In addition, with such known manometers a direct display is then no longer provided.

20 The invention is based on the problem of providing a manometer which can be used for monitoring hydraulic supports underground and has a satisfactory operating remote transmission of simple structure.

This problem is solved according to the invention in that the magnet is secured to the high strength Bourdon spring itself and the Hall generator is secured to the housing in exact alignment with said magnet, that the Hall generator is operable for temperature compensation in bridge connection with a constant current of about 2.5 mA and the housing is provided with an oil filling.

25 In such a manometer the magnet and Hall generator in the pressureless state are arranged at a very small distance apart and can thus be aligned very easily and accurately with each other. On a pressure change the Bourdon spring deforms and thus changes the distance of the magnet from the Hall generator. The distance change detunes the magnetic field, i.e. the magnetic induction. The high strength Bourdon spring used permits a multiple overload of the nominal pressure without such extreme values endangering the operation of the manometer. The Hall generator is simplified compared with those hitherto usual and for simultaneous temperature compensation operated in bridge connection with a constant current. The measuring signal which is proportional to the possible detuning of the bridge circuit lies in the range of 0 to 50 mV. The temperature fluctuations occurring in underground mining between winter and summer lie in a narrow region so that for them this compensation is adequate. Inherent oscillations of the system can advantageously be reduced by the oil filling of the pressure measuring means to such an extent that they have no detrimental effects. This is advantageous among other things because the face support system is moved at regular intervals of time and thus subjected to vibrations.

30 According to a convenient further development of the invention a particularly easy-to-repair construction is obtained in that the housing consists of two compact parts, one of which accommodates the Bourdon spring, the magnet, the Hall generator and a sealing head constructed as connection and the other the sealed-in electronics. In this manner the individual components can be maintained quickly and without great expenditure and in particular replaced. In addition, they are advantageously safely housed so that any disadvantageous influencing from the outside is largely eliminated.

35 The connection of the two parts is effected in particular in that the part of the housing receiving the electronics is made cup-shaped and beaded or flanged to the part receiving the measuring elements. Such a joint can easily be made and is tight enough for the intended operation to avoid any danger of emergence of the damping material, i.e. oil. In addition an advantageous passing on of the measuring signals and the like is possible.

40 According to the invention the securing points of Bourdon spring and Hall generator

are located at a neutral position directly adjacent each other so that in this respect as well a high accuracy of an economic remote pickup, with Hall generator, is ensured.

- 5 Preferably, the Hall generator arranged in the oil-filled housing is followed by a precision UF transducer so that an advantageous guiding and stabilizing of the voltage signal proportional to the bridge detuning is ensured. The
10 balance of the zero point (5 Hz) and of the nominal pressure (15 Hz) is carried out separately. This gives a high accuracy of the remote pickup. It is however also possible to define a usual operational narrower pressure
15 range by the balance and thus to "spread" with respect to the 5 to 15 Hz output. Finally, the entire circuit is secured against wrong poling in the usual manner by a diode.

- The use of frequency signals in the range of
20 5 to 15 Hz is usual in underground mining and has proved itself in that field. A disadvantage is that the time for reading the signals is long and consequently it is desirable to use signals of higher frequency. Nevertheless, an advantageous compromise is found here in that the
25 circuit is made so that it uses a frequency range of 500 to 1500 Hz and has a following dividing module. Via the corresponding module the signals in the frequency range 500 to
30 1500 Hz are divided by 100 so that once again the usual output signal of 5 to 15 Hz is achieved.

- If the Hall generators are used for control purposes the output signal of 5 to 15 Hz can
35 be supplied to an optocoupler and made potential-free by the latter. This coupler can be accommodated on an electronic printed circuit board of only 40 mm diameter with the prescribed minimum spacing of more than 6 mm.
40 Particularly advantageous is that the manometer according to the invention can without great expenditure also be equipped with a direct display by connecting a digital voltmeter and an LCD display after the Hall generator. In
45 this manner the voltage signal proportional to the bridge detuning simultaneously controls the output for the remote transmission and for the digital voltmeter. The combination of the direct and remote display and its control by
50 the common sensor provides apart from the same display at the face and in the supervising station operational advantages in particular as regards fault detection and early detection of disadvantageous developments.

- 55 Moreover, the intrinsic safety of the measuring system is increased by incorporation of an optocoupler and it is made possible to use measuring signals directly for control purposes of a great variety of types.

- 60 The present invention thus has a considerable technical advance consisting firstly in the high operational safety and convenient construction and secondly obtaining with one and the same sensor remote display and if desired
65 also direct display.

For further explanation of the invention an advantageous embodiment with its essential parts will be described hereinafter. In the drawings:

- 70 Fig. 1 is a front elevation of the manometer, partially cut away, and

Fig. 2 is a side view of the manometer in section.

- The manometer 1 shown in Figs. 1 and 2
75 with its housing 2 is so dimensioned that it is ideally suited for use in underground mining. The sealing head 3 permits connection to various valves to enable the pressure in the prop support or hydraulic support to be directly supervised. This prop pressure acts via the bore
80 4 on the inner components of the manometer 1. These inner components are dampened via an oil filling 6 introduced through the pressure compensation plug 5 in such a manner that
85 the Bourdon spring 7 disposed in the interior is secured against external vibrations.

Said Bourdon spring 7 comprises a magnet 8 fixedly connected thereto.

- In addition, in the housing 2 a Hall generator
90 9 is accommodated in the same part 11 of said housing 2 as the Bourdon spring 7 and magnet 8. The distance between the magnet 8 and the Hall generator 9 is very small when the manometer 1 is pressureless. When the
95 pressure changes the Bourdon spring deforms and is made of high strength to stand up to the particular conditions of mining with overloads, and this thus changes the distance of the magnet 8 to the Hall generator 9. The
100 distance change detunes the magnetic field, i.e. the magnetic induction.

- In the other part 12 of the housing 2 which is connected via a beading 13 to the part 11 the electronics 14 are accommodated. The
105 electronics 14 is part of a printed circuit board 15 which is accommodated in a sealing compound 16 safely in the part 12 of the housing.

- The plan view according to Fig. 1 clearly shows that the securing points 17 for the Bourdon spring 7 and the securing point 18 for the Hall generator 9 are accommodated closely adjacent to each other at a neutral position. This ensures exact location of these parts.

- 115 19 denotes a Kapton foil, 21 the flat band cable and 22 and 23 the cable screw connections and the cable itself.

- The processing of the bridge signal of the Hall generator 9 depends mainly on the desires of the particular mine. With an output of
120 5 to 15 Hz the voltage signal proportional to the bridge detuning and in the range of 0 to 35 mV is supplied to a precision UF transducer and stabilized. The balancing of the zero point (5 Hz) and the nominal pressure (15 Hz)
125 is carried out separately. This ensures high accuracy of the remote pickup. It is however also possible to define a usual operational narrower pressure range by the balancing and thus "spread" this range with respect to the
130

5 to 15 Hz output. The entire circuit is finally protected in the usual manner against wrong poling by a diode.

The use of frequency signals is not restricted to the range from 5 to 15 Hz. Reference to increasing the frequency range to 500 to 1500 Hz has already been made earlier on, the signal generated being divided internally by a module again by 100 to obtain the usual output signal of 5 to 15 Hz.

With an output of 0 to 5 volts the bridge signal of the Hall generator 9, which lies in the range of 0 to 15 mV, is amplified and stabilized. With an output of 4 to 20 mA the bridge signal is supplied to an amplifier which drives a precision current drain whose cut-off values can be equalized with the aid of 2 trimmers.

- 1 Manometer
- 2 Housing
- 3 Sealing head
- 4 Bore
- 5 Pressure compensation plug
- 6 Oil filling
- 7 Bourdon spring
- 8 Magnet
- 9 Hall generator
- 11 Part I of 2
- 12 Part II of 2
- 13 Beading
- 14 Electronics
- 15 Printed circuit board
- 16 Sealing compound
- 17 Securing point 7
- 18 Securing point 9
- 19 Kapton foil
- 21 Flat band cable
- 22 Cable screw connection
- 23 Cable (blue)

CLAIMS

1. Manometer with conversion of the pressure movement of the Bourdon spring accommodated in a closed housing via a Hall element serving as remote pickup and comprising a permanent magnet as exciter, which are associated with the Bourdon spring, characterized in that the magnet (8) is secured to the high strength Bourdon spring (7) itself and the Hall generator (9) is secured to the housing (2) in exact alignment with said magnet, that the Hall generator is operable for a temperature compensation in bridge connection with a constant current of about 2.5 mA and the housing is provided an oil filling (6).

2. Manometer according to claim 1, characterized in that the housing (2) consists of two compact parts (11, 12), one (11) of which accommodates the Bourdon spring (7), the magnet (8), the Hall generator (9) and a sealing head (3) constructed as connection and the other (12) the sealed electronics (14).

3. Manometer according to claim 2, characterized in that the part (12) of the housing (2) accommodating the electronics (14) is made

cup-shaped and is beaded to the part (11) accommodating the measuring elements.

4. Manometer according to claim 1, characterized in that the securing points (17, 18) of Bourdon spring (7) and Hall generator (9) are located directly adjacent to each other at a neutral position.

5. Manometer according to claim 1, characterized in that the Hall generator (9) disposed in the oil-filled housing (2) is followed by a precision UF transducer.

6. Manometer according to claim 1 and claim 5, characterized in that in a manner known per se a diode is connected to the Hall generator (9), the precision UF transducer and the associated circuit.

7. Manometer according to claim 1, claim 5 and claim 6, characterized in that the circuit is made using a frequency range of 500 to 1500 Hz and having a following dividing module.

8. Manometer according to claim 1, characterized in that the Hall generator (9) is followed by a digital volt meter and an LCD display.

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